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IMPACT OF TEMPERING PROCESS ON THE YIELD AND COMPOSITION OF QUINOA FLOUR [1]

Introduction

Roller milling is a dry-milling technique that aims to separate the anatomical parts of the seed kernel. Prior to milling, seeds are tempered to facilitate the removal of bran as the plasticity of the bran layer is increased by the absorption of water. Milling and tempering of wheat have been well-studied but these techniques require another approach for quinoa due to its different seed morphology and size.

Roller milling of quinoa is considered a technological challenge but the technique offers the opportunity to separate the different seed tissues. The separation leads to different fractions, rich in different target substances. These fractions can be used as separate food ingredients, which might stimulate the use of quinoa by creating more added value. Nevertheless, studies concerning roller milling and tempering of quinoa are rather limited. This study aims to investigate the impact of different tempering conditions on the roller milling of quinoa.

Material and methods

Three types of commercially available quinoa seeds (white quinoa: Q1, Q2; red quinoa: Q3) were roller-milled on small scale by a Brabender Quadrumat Junior. Two levels of tempering time (8 and 20 h) were combined with three levels of tempered moisture (13, 15 and 17%). Flour yield was recorded and the obtained flour was characterised by ash and protein content, and particle size distribution.

Chemical composition

Higher levels of tempered moisture (15 or 17 %) were beneficial to reduce the ash content of quinoa flour (**Fig. 1a**). The ash content of all samples was lower when the quinoa kernels were tempered at 15 % moisture. An additional reduction of flour ash content was observed for Q3 when tempering (8 and 20 h) occurred at 17 % moisture. Tempering at 17 % had no additional effect on the ash content of Q1 or Q2 flours when combined with a tempering time of 8 h. An increase in tempering time, at a fixed moisture level, generally resulted in a higher flour ash content. No effect of tempering time was observed for samples Q1 and Q3 if tempered at respectively 15 or 17 %, and 17 %.

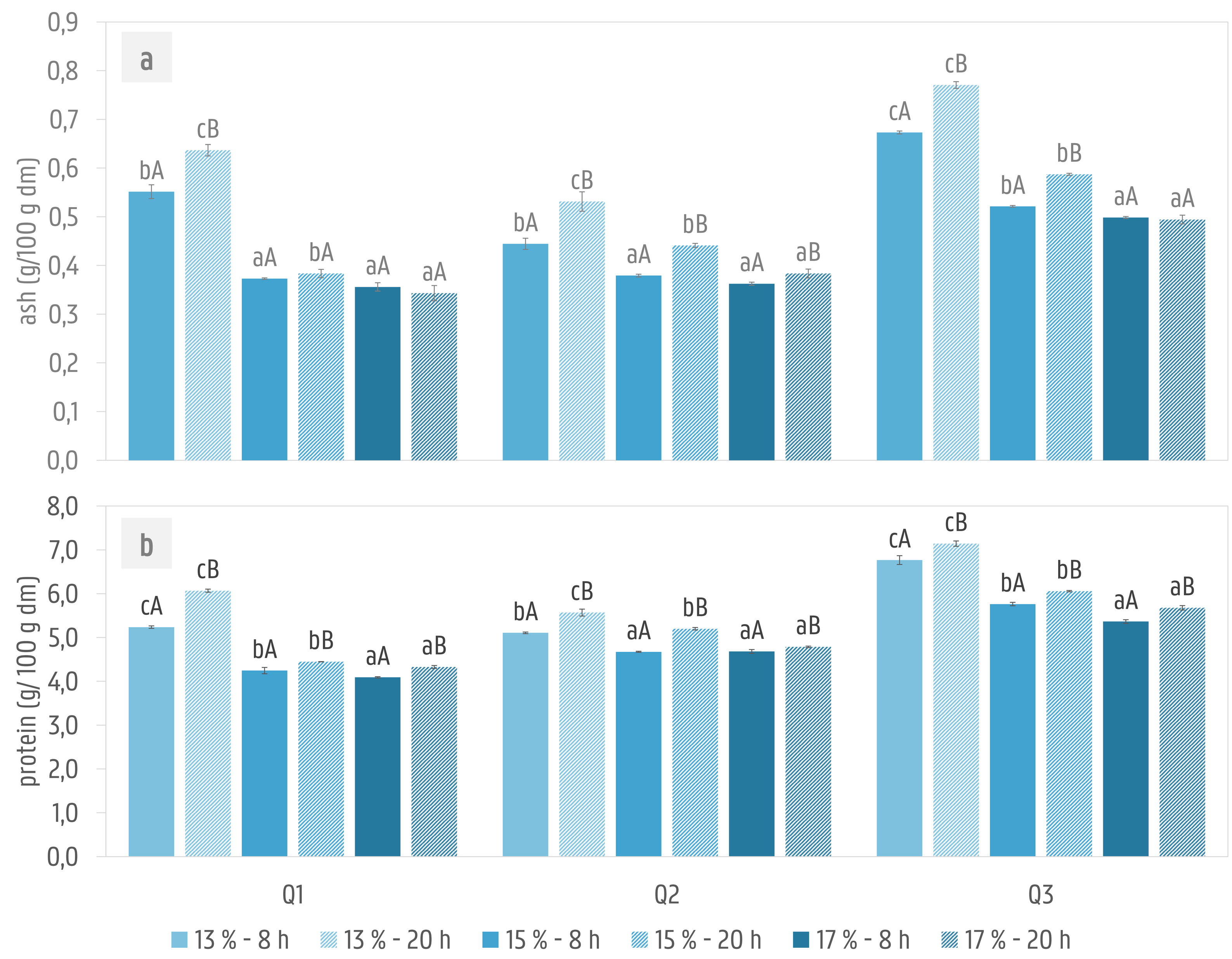

Fig. 1 Ash (a) and protein (b) content (g/100 g dm) of each quinoa flour (Q1, Q2 and Q3) per combination of tempering time (8 or 20 h) and tempered moisture (13, 15 or 17 %) (n=3) (A-B: effect of tempering time on flour ash/protein content per sample and level of tempered moisture, a-c: effect of tempered moisture on flour ash/protein content per sample and level of tempering time)

Samples Q1 and Q3 showed a significant decrease in flour protein content with every increase in tempered moisture: this was observed for both tempering times (**Fig. 1b**). Protein content of Q2 flours was highest if tempered at the 13 % moisture level. At higher moisture levels (15 and 17 %) the effect of tempered moisture was time-dependent for sample Q2: no difference in protein content was observed after short tempering (8 h), while long tempering (20 h) resulted in a higher protein content for moisture level 15 %.

Flour yield

Flour yields were maximal after tempering at 13 % moisture (**Fig. 2**). Milling trials indicated that tempered moisture influenced flour yields of all quinoa samples, while an effect of tempering time was only observed for sample Q3. An increase in tempered moisture resulted in a reduction of flour yield. The lowest flour yields were generally obtained for sample Q3; changes in tempering conditions could not increase the flour yield to the same levels of sample Q1 and Q2. The lower milling potential of sample Q3 could be ascribed to the smaller average kernel size, as small-sized kernels are associated with a higher bran to perisperm ratio and a lower potential flour yield.

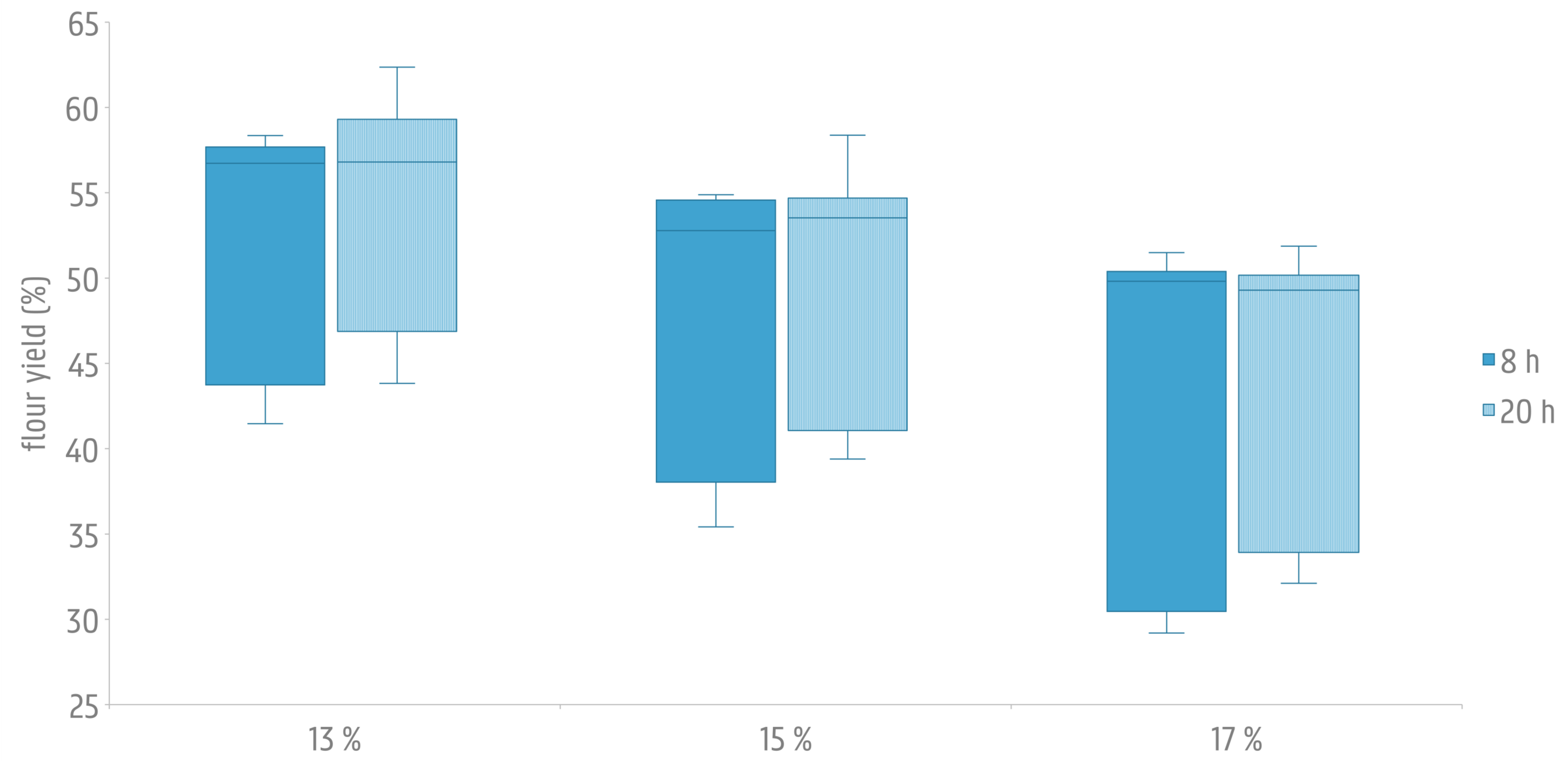

Fig. 2 Flour yield (%) per combination of tempering time (8 or 20 h) and tempered moisture (13, 15 or 17 %)

Particle size distribution

For samples Q1 and Q2, an increase in tempered moisture resulted in a reduction of all particle size distribution parameters (**Fig. 3a**). It is possible that the size of the bran particles sufficiently increased due to the higher tempered moisture and the separation of bran and flour by the sieve (mesh 200 µm) of the laboratory mill therefore improved. The fraction of large particles was considerably higher for Q3 flours (**Fig. 3b**) as compared to the other samples. This could be related to the small kernel size but could also be ascribed to the higher kernel hardness.

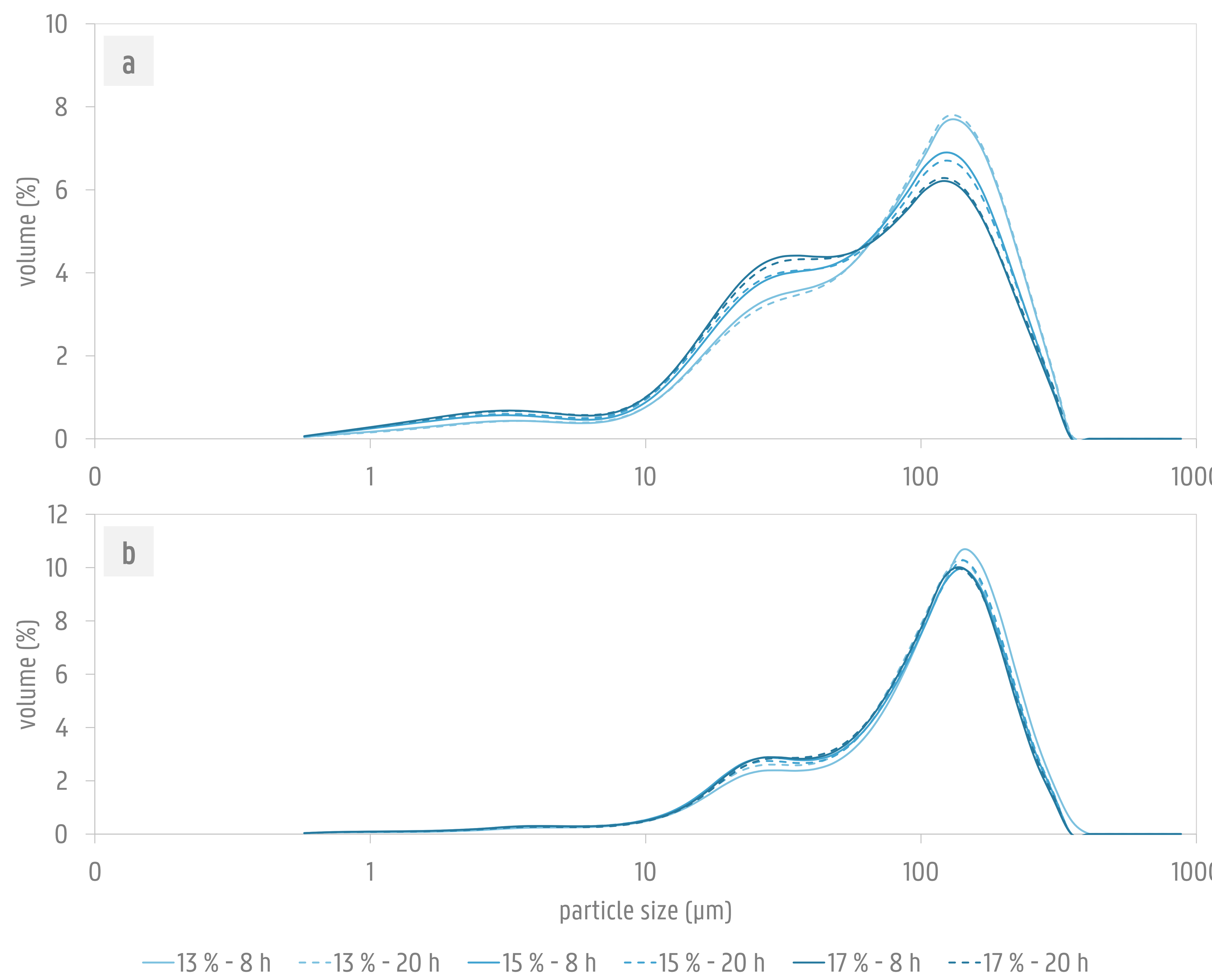

Fig. 3 Particle size distribution of quinoa flour (a = Q1, b = Q3) per combination of tempering time (8 or 20 h) and tempered moisture (13, 15 or 17 %) (n=3)

Conclusion

The flour milling process of quinoa kernels is mostly influenced by the applied tempered moisture: the flour yield decreases, while the bran-perisperm separation improves by increasing tempered moisture. Extension of tempering time has no effect on the flour yields of samples Q1 and Q2. The extension, however, tends to reduce the separation efficiency of the milling process as noticed by the increased ash and protein content of the resulting flour. Furthermore, this study suggests that the kernel properties have a distinct impact on the milling behaviour of quinoa: quinoa with a smaller kernel size led to a lower flour yield and flour with a different composition (ash, protein) and particle size distribution. Further research should look into the relationship between kernel properties and roller milling. Despite the differences in kernel properties, the 15 % - 8 h treatment resulted in an acceptable flour yield for all quinoa samples studied.

[1] De Bock, P., Van Bockstaele, F., Raes, K., Vermeir, P., Van der Meeren, P., & Eeckhout, M. (2021). Impact of tempering process on yield and composition of quinoa flour. *LWT, 140*, 110808.

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